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ABSTRACT

The development of a computer self-test program in geology at Macalester College, Minnesota, is described. Based on the philosophy that tests, particularly those involving no grading, are useful study devices, computers are used to make tests available to students. Ten lessons have been developed on different topics in geology, and the computer program for handling multiple choice tests is written in BASIC. Additionally, the number of times a question is tried and the number of times the correct answer is selected as a first choice is recorded in order to help determine how much class time to devote to various course topics. Microcomputers were implemented to enable the use of graphs, cross sections, or maps. Among other questions, the lesson asks students to arrange the rock units and the periods of erosion, folding, and faulting in order of relative age. Student reactions to the use of the computer were assessed based on questionnaire responses. The computer tests and lessons are used as an addition to the conventional lecture, discussion, and laboratory approach. The chief benefits of the computer lessons are: they provide a good means for review of subject matter, they help to identify problem areas, the computer recordkeeping provides the instructor with information on how well the class is learning various concepts and principles, and most of the students taking the computer tests or lessons have had no previous computer exposure. (SW)

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COMPUTER ASSISTED INSTRUCTION IN GEOLOGY

Introduction

Because I believe that tests, particularly those involving no grading, are useful study devices, I have for years provided copies of old tests that students could use for review. This practice had two distinct drawbacks. Before an actual class test the file of former tests often mysteriously disappeared, or at best too many students wanted to use it at the same time. Secondly, I was not always available to provide answers or to answer problems raised by the old tests during these rush periods.

In the summer of 1977, I attempted to solve these difficulties by loading multiple choice tests on our college computer. With some 30 terminals spread throughout the campus this overcame the access problem, and the computer program identified the correct responses.

This computer self test program was enthusiastically used by many students. In fact, response was so favorable that I was besieged by requests for more computer tests, requests that I was unable to fulfill because of time constraints. At this stage I applied for and was granted support from the National Science Foundation through their Local Course Improvement Program (LOCI) to revise, modify, and expand the self tests for two introductory courses, Physical Geology and Oceanography.

LOCI Project

Before the LOCI project started in July, 1980, we had three computer self tests in Physical Geology each encompassing material covered in about one month of class time. Because the subject matter was not presented in the same order each year, students using the tests began to encounter questions on material not yet covered in class. Also, because these original tests had been hurriedly assembled, it soon became clear

that some subject areas were missing in test questions.

In the first year of the LOCI grant we have made considerable progress in redesigning the test program to overcome these deficiencies. Instead of being assembled into discrete tests, questions are now stored in computer files according to subject matter. In oceanography, for example, we have files on introductory material, water, ocean chemistry, waves, tides, sediments, plate tectonics, biological oceanography and others. By examining individual files, it is an easy matter to see how thoroughly a topic is covered by questions. Moreover, the problem of editing and expanding files has been greatly simplified. Students now proceed as follows in taking a self test: (student input is lower case, computer upper case).

* * * * * * * * * * * * * *

run test

WHICH TOPIC DO YOU WISH? ocean chemistry

WHICH QUESTION? 7

7. WHICH OF THE FOLLOWING IS NOT A CONSERVATIVE CONSTITUENT OF SEAWATER?
(1) Cl (2) Na (3) Mg (4) O (5) K

ANSWER? 5

5 IS WRONG, TRY AGAIN.

* * * * * * * * * * * * * *

Although useful for review, our multiple choice test program does not allow for instructor feedback. During the summer of 1980, I attended a one month N.S.F. sponsored workshop on the CAI language COMMON PILOT directed by George Gerhold at Western Washington University. This introduction to computer assisted instruction (CAI) was very valuable and opened up many new

possibilities. Since then we have developed some 10 lessons on such topics as minerals, geologic time, crystallography and others. A section of our lesson on minerals runs as follows: (computer output in capitals)

* * * * * * * * * * * * * *

TELL ME, WHAT MAKES ONE MINERAL DIFFERENT THAN ANOTHER?

chemical composition

YOU ARE RIGHT SUSAN, BUT THAT CANNOT BE THE ONLY VARIABLE BECAUSE DIAMOND AND GRAPHITE ARE VERY DIFFERENT MINERALS YET THEY HAVE IDENTICAL COMPOSITIONS. WHAT ELSE ACCOUNTS FOR DIFFERENCES IN PROPERTIES?

* * * * * * * * * * * * * *

Work on expanding and editing the files of multiple choice questions and on generating new lessons in PILOT is continuing. Other improvements achieved with the LOCI support are described in the following sections.

Mainframe Computer

The college's PDP-11 computer is still the mainstay for this self test project. It has the advantage of memory size and availability because of the many terminals.

The computer program for handling multiple choice tests is written in BASIC. As part of the present project, we have refined it to record the number of times a question is tried and the number of times the correct answer was selected as a first choice. In February 1981, for example, each of the 90 questions on earth materials was tried some 50 times by a class of 35. The relation between the number of tries and correct first responses is useful in pointing out where students are experiencing difficulty. This information helps us to determine how much class time to devote to various course topics.

Although used chiefly for multiple choice tests, we have prepared several free form lessons in PILOT on the main computer. A major disadvantage of the system is that most terminals do not have graphics capability. Consequently graphs, cross sections, or maps cannot be used in questions. It is for this reason that we have moved some of the project to microcomputers.

Microcomputers

The LOCI grant provided funds for a terminal to be installed in the Physical Geology laboratory. Instead of a conventional terminal we purchased an APPLE 11 microcomputer which we can use alone or as a terminal to the main system. Student response to lessons written in APPLE PILOT using graphics was so enthusiastic that we have purchased a second unit.

It is very easy for even a novice to generate graphics with the APPLE PILOT graphics editor. Graphics are easily stored on diskettes and may be called into any program. The diagram and text below are from our lesson on geologic time. Among other questions, the lesson asks students to arrange the rock units and the periods of erosion, folding, and faulting in order of relative age. They are given a score on completion and, if the score is lower than 65 percent, the student is asked to see me for help. The following text is from about the middle of the lesson. I drew a block diagram similar to that shown here on the APPLE in about 15 minutes.

* * * * * * * * * * * * * * *

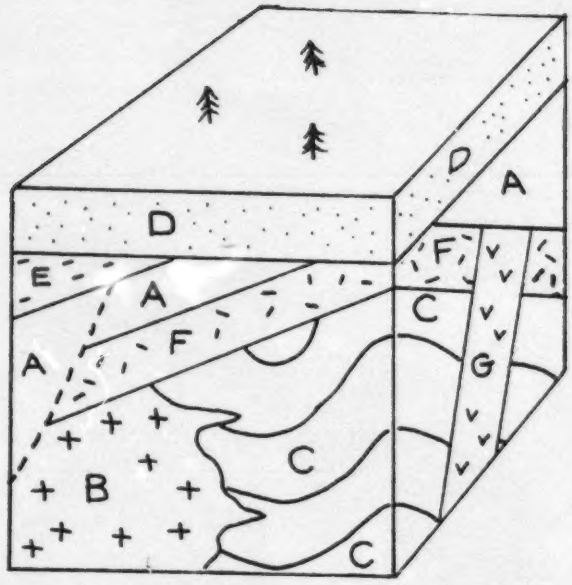
WHAT EVENT OR ROCK UNIT
FOLLOWED THE FAULT JIM?

rock unit E

WRONG. THE SURFACE MUST NEXT HAVE BEEN ERODED IN ORDER TO ACCOUNT FOR THE ABSENCE OF THE FAULT IN ROCK E.

WE ARE NOW AT THE EROSION SURFACE ON TOP OF ROCK A AND THE FAULT. WHAT IS NEXT JIM?

* * * * * *



When given the diameter the APPLE PILOT graphics editor draws circles at the press of a single key. It thus becomes a simple matter to draw cross sections of the earth, to construct silica tetrahedrons, or diagrams for questions related to Eratosthene's method of measuring the earth's circumference. During the summer of 1981 we are writing new lessons on the APPLE for use in future years.

Student Responses

About 120 students in four classes used the computer programs during the 1980-81 academic year. Of 92 students in three classes (mineralogy 16, physical geology 35, and oceanography 41) 82 were present and completed a questionnaire near the term end. Following are some of the results.

Did you use the computer tests during the term?

No	Infrequently	Frequently	Tried them all
1 (1%)	14 (17%)	25 (30%)	42 (51.5%)

Did you find the tests and lessons useful as study aids?

No	Slightly	Somewhat Useful	Very Useful
0	0	18 (22%)	64 (78%)

Students were asked to rate the multiple choice tests versus the free form PILOT lessons which usually included graphics. This was essentially a choice between the main computer, where only multiple choice tests were available, and the APPLE.

Multiple choice - 24 students rated this first (37%)

PILOT lessons - 44 students rated these first (63%)

Several respondents gave reasons for their choices. Two reasons for selecting multiple choice stand out. Only one microcomputer was available during the term so access was a problem. A second advantage of the main system frequently cited was the possibility of acquiring hard copy. Many students used decwriters to take multiple choice tests and kept the printout for later review in their dorms. Our APPLE does not have a printer.

Over 80 percent of respondents preferred to be given a score at the end of a test or lesson. In some of the PILOT lessons students are asked for their names and are subsequently addressed by name during the lesson. Opinion on the use or non use of names was split 50:50.

Following are some student comments taken from the questionnaire:

"The computer tests are the best study aid at the college."

"I enjoyed the tests, they were helpful and made studying fun."

"I would like to see more questions because they were helpful study aids."

Several students expressed frustration with some lessons that had been put on line too hurriedly with the result that students who did not respond in the exact fashion envisaged by the lesson author were caught in endless loops. It is important to test and refine lessons before giving them to a class. A further criticism that must be faced is contained in the following student comment.

"I think that a lot of people (myself included) tended to use them (tests) as the only study method."

Role of Computer Tests and Lessons

In spite of the expansion of the computer programs achieved with support from LOCI our basic philosophy concerning the role of the computer remains unchanged. We do not envision moving to a system where most of the instruction is by computer. The computer tests and lessons are simply an addition to the conventional lecture,discussion, laboratory approach.

The chief benefits of the computer lessons are:

1. They provide an excellent means for review of subject matter.
2. They help to identify problem areas. Students who have taken the tests and who need help come to the instructor with specific inquiries rather than vague general questions.
3. The computer record keeping provides the instructor with information on how well the class is learning various concepts and principles. Class time can thus be apportioned accordingly.
4. Most of the students taking the computer tests or lessons have had no previous computer exposure. The experience of logging in and communicating with a computer encourages some to go on to take a programming course.

Henry Lepp, Macalester College